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COSMIC X-RAY PHYSICS

Grant NAG 5-629

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ANNUAL PROGRESS REPORT

to

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Submitted by

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## "COSMIC X-RAY PHYSICS" (NAG 5-629) ANNUAL PROGRESS REPORT

### I. THE SOFT X-RAY BACKGROUND

Steve Snowden continued to work with the scientific staff of the Max-Planck Institut in preparation for using the data from the upcoming German X-ray astronomy satellite, ROSAT, to help in the analysis of our sounding rocket sky survey data.

Snowden, Cox, McCammon and Sanders have completed and submitted to the Astrophysical Journal a paper interpreting the sky survey B band count rate as an indicator of the extent of a cavity in the local interstellar medium.

McCammon and Sanders completed and submitted an article for the Annual Reviews of Astronomy and Astrophysics on "The Soft X-ray Background and Its Origins."

Juda, following up on his Ph. D. thesis research, continued working on the limits on absorbing material within the local cavity.

Edwards, as part of his Ph. D. thesis, has almost completed his analysis of our most recent (6 December 1988) sounding rocket flight. He has found that there is at least one direction on the sky, towards galactic coordinates (132, -69), where the ratio of the Be band count rate to the B band count rate differs from the value found in other parts of the sky. He interprets this as possibly due to absorption of the soft x-ray background by an intervening interstellar cloud. His spectral analysis of the Be band data found poor agreement between the measured pulse height distribution and that predicted to be emitted from a hot plasma in ionization equilibrium with solar abundances of the elements. Better agreement with the observed data was obtained when the abundance of iron in the model was reduced.

## II. PROPORTIONAL COUNTER AND FILTER CALIBRATIONS

Edwards completed analysis of the data he had collected the previous year at the Aladdin electron storage ring. These data consisted of high signal-to-noise measurements of the pulse height response to monochromatic low energy x-ray lines for two of the three UXT sounding rocket flight detectors. These measurements led to a better understanding of the response of the UXT detectors, especially in the neighborhood of the 72-eV Fe lines. (See above.) The measurements of the x-ray transmissions of some of the flight filters also aided in the understanding of the detector response.

## III. NEW SOUNDING ROCKET PAYLOAD: X-RAY CALORIMETER

We have successfully grown an iron alum crystalline salt pill suitable for the flight adiabatic demagnetization refrigerator (ADR). We intend to go ahead and make a spare while the undergraduates who did the work are still around. Details of the cryostat design are being completed, and we have a workable design for the thermal housings for the FETs. Extensive tests have been made of aluminum to fiberglass-epoxy glue joints at temperatures down to 77 K. We have developed a process for making joints that are reliably stronger than the composite, and therefore feel confident that we can use a simplified construction employing glued joints.

A great deal of effort has gone into screening various varieties of FETs for the preamp. The best we have found so far are NJ-14ALs from Interfet, which have noise levels around  $2.5 \text{ nV}/\sqrt{\text{Hz}}$  and corner frequencies below 10 Hz. They will not operate satisfactorily below 110 K, however, and

must be run with Vdg below 2 volts to stay below the Ig breakpoint where current noise increases rapidly.

The aluminum beam supported calorimeters we have been fabricating have just the right thermal conductivity through the Al supports, but have a serious problem in that most of the energy in an X-ray pulse goes into a very long tail with a decay time exceeding 30 ms (for a detector with a thermal decay time, C/G, of 1 ms). Our current thinking is that this is due to quasiparticle formation in the Al beams, but it is not clear why the fraction of the energy tied up this way should be so large. We hope to get back to the physics of this before too long, but for the time being are working with the all-silicon devices being produced at Goddard. One of these (with a HgTe absorber) has achieved 11 eV FWHM energy resolution for 6 keV X-rays, and 8 eV at low energies.

#### IV. THEORETICAL STUDIES

The principal thrust of the theory effort during 1989 was completing work on the code for studying supernova remnant evolution in diffuse media, deciding on the significant observables to calculate, and reviewing the observational information on the diffuse interstellar conditions in which the explosions would occur.

A preliminary paper on the surprises in store for the supernova remnant evolution was presented by Cox and Slavin at the Berkeley EUVE meeting in January. The diffuse ISM review and the effects that the new SNR evolution results have on our understanding of the medium were presented in invited reviews at Granada (IAU Colloquium No. 120) in the spring and the Tetons (2nd Wyoming ISM Conference) in July. The Granada paper also presented new

ideas on the ionization mechanism and ionization structure of the medium, while the Tetons paper discussed the disturbing coincidence between the rates of supernovae and cloud heating.

The picture we have of the diffuse ISM is being altered dramatically as a consequence of recent observational studies and the theoretical effort we are supplying to draw them into focus. The medium is characterised by a much larger role for diffuse warm gas, with a very large scale height and significantly larger nonthermal pressure than previously appreciated. This strongly affects our understanding of galactic formations, superbubble evolution, high stage ions, magnetic field generations, and the general pervasiveness of hot gas in the medium.

On other fronts, the group effort to elaborate a clear description of the Local Bubble culminated in the submission of the Snowden et al. paper. The hydrostatics paper of Boulares and Cox was withdrawn from Ap. J. and underwent substantial revision in response to the rapidly developing observational constraints. It was then resubmitted and will appear in the Ap. J. in 1990.

A new graduate student, Warren Miller, was started on a project to determine the theoretical pattern of the diffuse ISM ionization structure due to OB stars in the solar neighborhood.

Progress seemed painfully slow but there were so many careful details to be concerned with. It is good now to be past that period, with results in hand and many new exciting applications for the codes we have developed.

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January 1, 1989 to December 31, 1989

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PUBLICATIONS

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- "Supernova Remnants and the Nature of the Cosmic Ray Electron Spectrum,"  
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CONFERENCE PROCEEDINGS

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COLLOQUIA AND SEMINARS

"The Galactic Diffuse X-ray Background and the Small Scale Organization of the Interstellar Medium," D. McCammon, Univ. of Virginia Astronomy/ National Radio Astronomy Observatory Colloquium, 23 March 1989, Charlottesville, VA.

"Progress and Problems in Understanding the Interstellar Medium," D. P. Cox, University of California Santa Cruz Astronomy Colloquium, January 1989.

D. P. Cox, U. Wisconsin Plasma Seminar, September 1989.

D. P. Cox, Ohio State University Astronomy Colloquium, October 1989.

D. P. Cox, U. Wisconsin Astronomy Colloquium, Fall Semester 1989.

"Spectroscopic Observations of the Soft X-ray Diffuse Background,"

W. T. Sanders, U. Wisconsin Astronomy Colloquium, 17 October 1989.

"Observations of the Hot Interstellar Medium," W. T. Sanders, Los Alamos

National Laboratory Astrophysics Seminar, 27 October 1989.

"Soft X-rays from Interstellar Space," W. T. Sanders, U. Wisconsin

Meteorology Colloquium, 30 October 1989.

D. P. Cox, North Carolina State Physics Colloquium, November 1989.

D. P. Cox, Rice University, Space Physics Colloquium, December 1989.

PUBLIC SERVICE LECTURES

D. McCammon, Wisconsin State Science Symposium presentation (program for high school students), Madison, 2 March 1989.

"Cryogenic Particle Detectors," D. McCammon, Talk for SPS - Zone 8 Meeting, Madison, 14 October 1989.

